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ALONE OR AS AN ADDITIVE: PE-UHMW IMPROVES THE PROPERTIES OF MATERIALS
[Wie geschmiert
Allein oder als Additiv: PEUHMW verbessert Werkstoffeigenschaften]

Stanislaw Haftka et al.

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ALONE OR AS AN ADDITIVE: PE-UHMW IMPROVES THE PROPERTIES OF MATERIALS

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Ultrahigh molecular polymers are multitalents if sliding ability, wear resistance, and resistance to chemicals are called for. Thus, they are suitable as reliable materials for, among other things, pumps, fittings, and transport systems. As micropowders, they can now also enhance other plastics and dyes and coatings.

As probably no other plastic, Polyethylene Ultra High Molecular Weight (PE-UHMW) is used in large-area applications to improve sliding ability. Silos, floors of freight vehicles, and holds of cargo ships are lined with ultrahigh molecular polyethylene, which is sold, for example, by Ticona, under the name GUR. However, the chemistry and pharmaceutical industries also use the very good sliding properties and the high wear resistance of the material for material handling engineering and packaging technology and in pumps, fittings, sealings, nozzles, stirrers, and stripping elements.

Figure 1. ...[not legible]...unit for cleaning substances is equipped with a multiple-stage, star-shaped element, conveyor screw....made of PE-UHMW.

The key to understanding the material properties lies in the extremely high molecular weight of 3.9 to 10.5 million g/mol. With increasing molar mass, some technically important properties of polyethylenes improve; wear resistance, notched bar impact value, dimensional stability under the influence of heat, resistance to the formation of stress cracks, and energy absorption capacity with a high rate of stress.

It is the sliding ability which particularly qualifies PE-UHMW for the storage and transport of powdery, granule-shaped, and dusty bulk goods. Due to the low coefficient of friction, substances of this kind slide without any problems into supply bins and transport containers via channels, chutes, and funnels. In this way, the "caking" of the solid products, above all, is prevented, which can otherwise easily interrupt the supply of material and lead to operation disruptions. At the same time, the material is resistant to chemicals, and light and temperature-stable in a wide range, from -180 to 80°C.

The highest molecular weight for the lowest friction

As a result of the very high molecular weight, the processing of the raw material, which can be obtained in powder form, is concentrated in special extrusion and press-sinter and form-sinter methods. Various basic types, modifications, and specialty grades are available, for example, material equipped for antistatic or heat-conductive properties, and microglass bead-reinforced GUR with a harder surface.

For the lining of containers, mostly plates are used, which are affixed with screw, rivet, or bolt solder connections. An interesting alternative is a composite material in which the PE-UHMW is connected to a rubber layer so as to be undetachable. This material combines the robustness of the ultrahigh molecular polyethylene with the dampening properties of rubber, which is foreordained, for example, for transport chutes, sliding guide rails, or as pile-drive protection.

Chain and belt guides, deflection rollers, curve guides for repackaging are typical examples of the use in material handling engineering in which the good sliding properties in combination with high wear resistance are called for. In comparing the abrasion (volumetric wear) of various important materials, measured according to the sand-slurry method, it is evident that the wear resistance of PE-UHMW is above that of St 37 steel. Polytetrafluoroethylene (PTFE) likewise has good sliding properties but due to the far lower abrasion resistance, comes off badly when used in a material flow.

Since high-molecular polyethylenes are of no concern physiologically, they are also used for the production of parts for filling units that come into contact with media, in particular, filling heads, in the food and pharmaceuticals industry (Figure 1). Thus, for example, the machine manufacturer EME decided on this material with the filling heads of a 24-head filling machine, which fills up to 250 glasses per minute, In spite of the high throughput, the glasses should not be damaged, on any account, when the filling cylinder is placed, which is guaranteed with the high energy absorption and good dampening of PE-UHMW. Rings made of GUR also assume the guiding of steel filling pistons.

Figure 2. The material is particularly suitable for moved parts, for example, in pumps, because of its good sliding properties.

Improve the running capacity of pumps

Like all polyethylenes, the ultrahigh molecular version is also resistant to aggressive media. Only strongly corroding acids are to be avoided. Since polyethylenes are water-repellent and thus do not exhibit any swelling tendencies, the good sliding properties of PE-UHMW in pump parts, such as the impellers, membranes, or eccentric plates, can be utilized (Figure 2).

Large pumps manufactured at the FRIATEC-Rheinhuette in Wiesbaden convey, for example, process water to clearing basins. The pumps, which work without clogging, attain in one application a throughput of 600 m^3/h with a conveyance height of 32 meters and are in operation for many years, without long interruptions. The good resistance to wear, resistance to acidic and alkaline conveyance media, and the temperature stability in the range of -50 to 80°C are also decisive, for selection of the material.

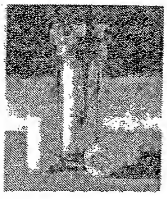

Figure 3. Special polyethylene types make possible the production of uniformly porous materials for filtration uses.

One specialty of ultrahigh molecular polyethylene is processing to porous molded articles and foils, which, for example, are used with fluidized bed plates, for venting installations, and air and water filters (Figure 3). These special GUR types have a precisely defined molecular weight, have a tailored particle morphology, and a strictly controlled distribution of the particle sizes. During sintering, the polymer particles melt at their contact parts, wherein a porous structure is produced. As a result, one obtains components or semi-finished products in which porosity and flow resistance can be adjusted in a particularly precise manner. Large-area and voluminous filters with a very high consistency of properties are possible. Thus, for example, Herding developed sinter metal filters in the 80s, which have been used worldwide since then, in order to remove toxic and explosive dust types from the waste air from coloring powder units or coating units.

Modify other materials with micropowders

GUR micropowders, which were introduced in August and which have an average particle size of 30 to 60 µm bring new perspectives. As an additive, they are used in dyes, plastics, rubber materials, and

sealings. Plastics with a GUR additive attain, for example, a better sliding capacity and higher abrasion resistance. As an admixture in dyes and coatings, the result--aside from a higher abrasion resistance--is an improved surface in the form of texture and delustering. Rubber materials, in turn, obtain a higher sliding coefficient, are most stable with respect to chemicals, and also more abrasion-resistant. In this way, it is possible to combine the positive properties of PE-UHMW with the strengths of other materials.

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Ultrahigh molecular polymers

With increasing molar mass, some technically important properties of polyethylenes, such as wear resistance, dimensional stability with heat influence, and sliding capacity, are improved. PE-UHMW (polyethylene Ultra High Molecular Weight) with a molecular weight of 3.9 to 10.5 million g/mol is therefore used, for example, in material handling engineering and for the manufacture of components for pumps and fittings. Micropowders of ultrahigh molecular polyethylene, with a particle size of 30 to 60 µm bring new perspectives. Used as an additive, it is possible to purposefully change the properties of, for example, plastics and dyes.